stances attaching to the chair almost preclude possibility to treat its subject as a province of experimental science. Physiology, inseparable from chemistry and physics, could, one might have imagined, at an Institution so famous for the character of its lectures on those subjects, have been advantageously placed. That, from Prof. Waller's letter, is evidently the reverse of its present case at the Royal Institution. Not a workroom, even of the smallest size, could he obtain for conduction or preparation of his experiments. This must be a revelation to many who know the Institution as connected with the names of men, such as Davy and Faraday, who contributed by research to physiology—who, in other words, considered the chemistry and physics of living material as well as that of dead to lie within the scope of study and inquiry supported by the Institution. It is true that the Fullerian chair of Chemistry has proved fruitful in measure exceeding the productiveness of the Fullerian chair of Physiology. The latter has been declared comparatively sterile. This is regrettable; but its reason does not seem far to seek. Both chairs have been held by men of high distinction; but the former has rested upon a laboratory, while the latter—so far from resting upon a laboratory—"does not possess even one small room in which to keep itself alive." Is this condition irremediable? I ask although by circumstance outside the Institution; and ask simply as one interested in the welfare of physiological science, and as a unit of a public who esteem the Institution as a place of instruction for the educated masses of a great city where at present such opportunities as the Institution offers are lamentably few.

Liverpool, December 31, 1897. Ch. S. Sherrington.

A Mechanical Theory of the Divining Rod.

The review in Nature (October 14, 1897, pp. 568, 569) of a publication relating to the "divining rod," recalls to my mind a purely mechanical theory of that rod, which was given me years ago by a friend.

This theory has been repeatedly tested by me and shown to be correct in the presence of my classes. The process is exceedingly simple. Take any forked twig of a reasonably tough fibre in the clenched hands with the palms upward. The ends of the limbs forming the twig fork should enter the closed fists on the exterior side of each fist, *i.e.* on the two sides of the clenched hands furthest from each other.

When a twig is grasped in this position it will remain stationary if held loosely, or with only a moderately firm grasp; but the moment the grasp is tightened, the pressure on the branches will force the end of the twig to bend downwards. The harder the grip the more it must curve.

The curvature of the twig is mechanically caused by the pressure of the hands forcing the limbs to assume a bent and twisted position; or the force that causes the forked limb to turn downwards is furnished by muscles of the hands, and not from any other cause.

The whole secret of the "divining rod" seems to reside in its position in the hands of the operator, and in his voluntarily or involuntarily increasing the closeness of his grasp on the two ends of the branches forming the fork.

If the above conditions are fulfilled the twig will always bend downwards—water or no water, mineral or no mineral; any one can be an operator, and any material can be used for the instrument, provided the limbs forming the fork are sufficiently tough and flexible.

It can be easily understood how an ignorant operator may deceive himself, and be perfectly honest in supposing that some occult force, and not his hands, causes the fork to curve downwards. M. E. Wadsworth.

Michigan College of Mines, Houghton,
Michigan, December 8, 1897.

Growth of the Tubercle Bacillus at a Low Temperature.

A broth culture of the tubercle bacillus a month old was filtered through a sterilised Berkfeld filter; the filtrate was ascertained to be sterile; it was then sown with a trace of *B. tuberculosis* and incubated at a temperature varying slightly between 18°–20° C., but never higher than 20°.

The bacillus developed well, but not so rapidly as at the customary temperature, *i.e.* 37·8° C.; the growth had not the usual flocculent appearance, but was granular.

Microscopically the organism was unchanged.

London, December 20, 1897. F. J. Reid.

THE STORY OF GLOUCESTER.

1979 cases of small-pox, 434 deaths; or a mortality of 21·9 per cent. during a period of thirteen months.

	Cases.	Deaths.	Percentage mortality.
Previously vaccinated ...	1211	120	9·8
Unvaccinated	768	314	40·8
	1979	434	

SUCH, in brief, is the story told by Dr. Sidney Coupland in his Report to the Royal Commission on Vaccination on the outbreak of small-pox in the city of Gloucester in 1895-96.

These figures, in all their baldness, convey a lesson such as no long garnished account can accentuate or emphasise; but in Dr. Coupland's Report a number of most interesting facts and statistics have been brought together, which will form the basis of many future reports and arguments.

One of the most interesting points brought out, apart from the mortality, was the proportion of severe and mild cases in vaccinated and unvaccinated patients. Of those vaccinated in infancy, there suffered from—

		Per cent.		
Malignant small pox		2·4	of the whole	of those attacked.
Confluent	,,	19·1	,,	,,
Coherent	,,	9·6	,,	,,
Discrete	,,	28·7	,,	,,
Mild	,,	40·0	,,	,,

When we come to those who are said to have been vaccinated, but of which there is no very strong evidence, we find:—

		Per cent.		
Malignant small-pox		17·5	of the whole	of those attacked.
Confluent	,,	52·5	,,	,,
Coherent	,,	10·0	,,	,,
Discrete	,,	12·5	,,	,,
Mild	,,	7 5	,,	,,

Being a marked rise in malignant and a great fall in mild cases.

Amongst the unvaccinated the proportion of severity of attacks at all ages was:—

			Per cent.
Malignant small-pox		... ...	5·0
Confluent	,,	... ...	72·3
Coherent	,,	... .	10·3
Discrete	,,	... ...	8·7
Mild	,,	... ...	3·6

Showing a very high percentage, indeed, of the severe type of case.

These figures are given in full because they afford evidence, quite apart from the mortality, of the enormous influence that vaccination exerts on the course of an attack of small-pox.

The Gloucester epidemic appears to have differed from almost every other recent outbreak of small-pox in the fact that its incidence was especially heavy on infants and young children. Below one year the proportion of deaths was no fewer than 14 per cent. of the whole, whilst at ages from 1 to 10 years it was exceedingly heavy—50·4 per cent. This, of course, was accompanied by a corresponding diminution in the proportion of deaths at later years; and from 10 to 30 years the proportion had fallen to 12·6 per cent., though from 30 years and upwards (the effect of early vaccination having worn off to some extent) it had again risen to 22·7. When these figures are compared with the earlier outbreak of 1873-75 in Gloucester and with the Dewsbury and Leicester outbreaks, it is found that the proportion of deaths amongst children is exceptionally high. It was noticed, too, that the disease spread amongst these children with enormous rapidity, and that it occurred amongst them in an exceptionally severe type, both as regards the proportion of malignant cases and the height of the mortality.

It is certainly not going beyond the facts of the case to state that the above-mentioned characteristics of this epidemic must in great measure be attributed to the large number of unvaccinated children who were in attendance at school, and who were thus not only extremely susceptible to the attacks of small-pox, but were in a position to disseminate the disease, though in a milder form, amongst those who had been vaccinated. That is, the neglect to have the children vaccinated left them in a condition in which they would readily take small-pox just at the time when their surroundings were of such a nature that everything was favourable to their taking the disease from one another, and in turn passing it on to those with whom they daily came in contact; with the result, as Dr. Coupland points out, that one in twenty of the whole population of Gloucester were struck down with small-pox. Indeed, he goes so far as to say that, "viewing the subject with as impartial a mind as I can, the conviction is forced upon me that Gloucester would not have suffered as it did had its child population been vaccinated." It was this want of vaccination, and the impossibility of maintaining effective isolation of the attacked, that allowed of the abnormally rapid spread of the disease after it has once obtained a firm hold in the city.

If there was one more important feature than the rapidity of the outbreak, it was that the epidemic faded away—for that is the only term that can be applied—so abruptly. Numerous explanations have been put forward to account for this, but the only factor that appears to have had any real determining influence in bringing about this abrupt cessation of the disease, was the universal adoption of re-vaccination after small-pox had already obtained its firm foothold in the city.

That Dr. Coupland is not going beyond his brief when he holds that this high child mortality was due to the unvaccinated condition of many of the children, is evident from certain statistics which he gives concerning 3546 cases. Of these only 85, or 2·5 per cent., were in vaccinated children below the age of ten years; and amongst these 85 cases there was only a single death.

These were all cases recorded in papers and reports which had come directly under Dr. Coupland's personal observation during his investigations into the outbreaks of small-pox in Dewsbury, Manchester, Oldham, Leeds, Halifax, Bradford and Leicester. In the Dewsbury, Leicester, and Gloucester outbreaks the number of children that had not been vaccinated was very high indeed. Now, taking Dewsbury, where the proportion was lowest, the number of deaths to attacks was as one to nine; in Leicester, as one to seventeen; and in Gloucester—where the proportion of unvaccinated was highest of all—the proportion of deaths to attacks was as one to four and a half, although the attacks in Gloucester were nearly 2000 (1979), in Leicester 357, and in Dewsbury 1029.

Comparing these three outbreaks, and bearing in mind the proportion of unvaccinated as above, we find that the proportion of the whole number attacked under ten years was in Dewsbury 21·7 per cent., in Leicester 30·5 per cent., and in Gloucester 35·6 per cent.; the fatality of this class in the three cases being Dewsbury 25·4 per cent., Leicester 13·7 per cent., and Gloucester 39·6 per cent.

As affording evidence of the disproportionate incidence of the disease upon young children, to which reference has already been made, it may be stated that 706 of the whole number attacked, or 35·7 per cent., were under ten years of age; whilst of the 434 fatal cases 280, or 64·5 per cent., occurred in this age period. Of these 706 only 26 had been vaccinated before the epidemic broke out, whilst of the remainder, 80 were undergoing vaccination when attacked with small-pox, the operation having been performed within fourteen days of the onset of the disease. It will thus be seen that only 4 per cent. of those attacked at this age period had been vaccinated, although a much larger proportion of vaccinated had been exposed to infection. It is found that of those exposed to infection, in households invaded by small-pox, of the vaccinated class 3386, and of the unvaccinated class 1475, there were attacked with small-pox—of the vaccinated class 1028, or 30·3 per cent.; whilst of the unvaccinated class 689, or 46·6 per cent., became infected.

It has already been indicated that amongst the unvaccinated at Gloucester the type of the disease was much more severe than in the vaccinated class. For purposes of comparison it may be shown that in Gloucester, where, as we have already seen, the number of unvaccinated children was very high—much higher than in Dewsbury or Leicester—the type of the disease over all was much more severe than at either Dewsbury or Leicester, and still more so than in many of the other recent outbreaks. Taking the severe type as including malignant and confluent cases, and the milder type as including coherent, discrete and mild cases, we find that in Dewsbury 26·5 per cent. of all attacks were of a more severe type, in Leicester 26·8 per cent., and in Gloucester 43·1 per cent.; whilst the mild type accounted for 27·5 per cent. in Dewsbury, 35·5 in Leicester, and only 25·5 in Gloucester.

If we now take out Dr. Coupland's figures as regards attacks of small-pox affecting vaccinated and unvaccinated patients, we find that in Dewsbury 64·3 per cent. of the whole number, with a mortality of 2·7 per cent., were vaccinated; in Leicester 55·8 per cent., with a mortality of 1 per cent.; in Gloucester 61·2 per cent., with a mortality of 9·8 per cent. These figures compare very favourably with the cases of deaths in the unvaccinated class. There were 35·7 per cent. of the whole cases that had not been vaccinated in the Dewsbury Union, and amongst these there was a fatality of 25 per cent.; in Leicester 44·3 per cent. of the cases were unvaccinated, with a death-rate of 12 per cent; whilst in Gloucester 38·8 per cent. of the cases had not been vaccinated, and amongst these there was a death-rate of 40·8 per cent. It will thus be seen that the lowest death-rate in the unvaccinated class (12 per cent. at Leicester) was considerably higher than the highest death-rate in the vaccinated class (Gloucester, 9·8 per cent). It must be borne in mind, of course, that even in the worst vaccinated districts the proportion of unvaccinated to vaccinated persons is very much lower than the proportion of vaccinated small-pox cases to non-vaccinated cases, so that we not only have an enormously greater mortality amongst those attacked, but the percentage of attacks is also considerably higher.

Any one who goes carefully and with unbiassed mind into the statistics collected by Dr. Coupland must inevitably come to the conclusion that, although the disease was spread in schools owing to the simultaneous infection of school children from cases unrecognised by, or unknown to, the authorities until the area of infection had been considerably widened; although after the sudden outbreak of small-pox it became, first, a difficult—and eventually an impossible—task to isolate the patients attacked, and to treat even a small proportion in hospital; and although insanitary surroundings and a certain amount of overcrowding may have played some part in spreading the disease, we must ultimately fall back upon the neglect of a large number of parents to see to the vaccination of their children for an adequate explanation of the extent of the epidemic and the rapidity of its extension. The utter futility of all ordinary measures recommended for the limitation of the spread of small-pox, apart from vaccination, is only too clearly brought out.

Hospital accommodation and isolation are usually insisted upon, by those who do not believe in vaccination, as being sufficient to prevent any outbreak of small-pox assuming serious epidemic proportions. Now, what did Dr. Coupland find at Gloucester? That a few slight or mild cases in 1895 were followed by a severe epidemic extending from February to April 1896, in which not only was there an increase in the numbers attacked, but there was also an undue proportion of cases of a severe type accompanied by a high rate of mortality. As showing how in a community with a large proportion of unvaccinated children the disease may spread rapidly, we have the fact that there was an "almost simultaneous invasion of many homes through children who were infected whilst attending certain of the public elementary schools." As a result of this sudden outbreak it became impossible to provide hospital accommodation, and, ultimately, all attempts at isolation, of even a modified form, had to be abandoned as utterly impracticable. As a result of the crowding of the hospitals, and of the removal of the most severe cases to them, the hospital mortality was comparatively high, and the friends of the patients would soon not permit of the removal of these patients to hospitals; this, of course, resulting in an utter break-down of the system of isolation.

Dr. Coupland sums up in the following exceedingly striking passages. He says: "There is no escape from the conclusion that the heightened mortality and the severity of the epidemic were greatly due to so large a proportion of unvaccinated children being attacked; for (*a*) the case mortality under ten years of age was 39·6 per cent., whilst amongst the vaccinated it was only 3·9 per cent., leaving a mortality amongst the unvaccinated of 41 per cent. . . . (*b*) The disparity is quite as marked when the type of the attack is contrasted, for of 507 cases of *severe* attacks [malignant, confluent, indeterminate] there actually occur only three amongst the vaccinated." From these and other considerations it follows that in the Gloucester epidemic "the severity of the disease, its high mortality, and its propagation were influenced and promoted by the unduly large proportion of unvaccinated children who were exposed to infection and who were infected."

To whatever figures or tables we turn, the effect of them is always the same. They tell the same story — vaccination protects; unvaccinated children are left susceptible to the attacks of the disease, and they not only take the disease more readily, but they take it in a more dangerous and fatal form, and, in most cases at any rate, are a source of greater danger to those with whom they may come, directly or indirectly, in contact. Isolation, good hospital accommodation, and favourable sanitary conditions are useful in the treatment of small-pox in a vaccinated community; but once let small-pox find its way into an unvaccinated community, the inefficiency of these "accessory" measures, when used alone, are demonstrated with the most absolute clearness; and if Gloucester has one lesson more than another to teach, it is that Jenner, by his advocacy of vaccination, did more to limit the spread of small-pox than have all the sanitarians of the century. Small-pox undoubtedly does not come under the class of diseases that can be held in check by ordinary sanitary measures; these, no doubt, are contributory, but without vaccination they can never be depended upon as being fully effective.

CANADIAN GEOGRAPHY.

THE reissue of "Stanford's Compendium" now includes Australia and the Pacific Islands in two volumes by separate authors, Asia in two volumes and Africa in two volumes by the same author, and vol. i. of North America.[1] The new issue is in many ways vastly superior to the old; the cramping influence of the foreign original has disappeared, the illustrations have greatly improved, and, linked by the general title, each of the volumes forms a separate and original work of distinct value. So good, indeed, has "Stanford's Compendium" become, that it may now be allowable to subject one of its volumes to criticism of a more searching kind than would have been justified formerly. Then any attempt to form a library of solid geographical works in the English language was worthy of commendation; now it is possible to set up a higher standard, and it is reasonable to look for those excellencies of grasp and arrangement which one naturally expects in, let us say, a German work of similar scope.

The morphological unity of the continent is one of the fundamental facts of modern geography. The continent is the natural unit which must be considered in its entirety, with parts subordinated to the whole, and with functional activities of a distinctive kind. It is capable of subdivision, either naturally into regions or artificially into countries, and of aggregation with other continents to form the whole land-surface. The dominant lines of the continent—its axial mountain systems—determine the primitive slopes of the land, and the development of the river systems, subject to the continuous workings of secular uplift or depression and the accumulation of sediment. The resulting configuration modifies the climate as dependent on latitude, and leads to the formation of areas of moderate and of extreme temperature, of high rainfall and of aridity. Climate reacts on vegetation, and vegetation and climate together influence the distribution of animals; and all these varieties of feature and function are framed in the continent. Thus up to the appearance of man a geographical description must be based on the continent as a unit if it is to be really simple and comprehensible. With the advent of man complications arise, but the guiding influence of the main features of continental relief and surface-covering is still to be traced. The deep inlets tempt the adventurous stranger to penetrate the continent, the easy waterways lure him into the interior, where products of forest and plain supply an adequate inducement to remain or to return. In time groups of people settle down in habitats more or less distinctly defined by natural features—different tribes frequent the river, the lake, the forest, the plain, the mountain valley, the indented ocean shore.

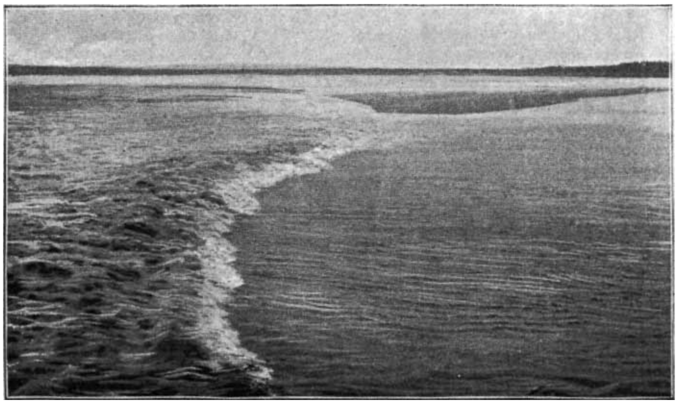

FIG. 1.—The Bore, Petitcodiak River, Moncton, New Brunswick, August 8, 1892. Height, 5 feet 4 inches.

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[1] "Stanford's Compendium of Geography and Travel" (new issue). North America. By S. E. Dawson. Vol. i. Canada and Newfoundland. Maps and illustrations. (London: Edward Stanford, 1897.)